

INDOOR AIR QUALITY ASSESSMENT

Particulate Testing of Laser Jet Printers

**Department of Revenue
35 Congress Street
Shetland Park Office Park
Salem, MA**



Prepared by:
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Bureau of Environmental Health
Indoor Air Quality Program
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Background/Introduction

At the request of the Service Employees International Union (SEIU), the National Association of Government Employees (NAGE), Massachusetts State Coordinated Bargaining Council (MSCBC), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted testing for airborne particle matter with a diameter less than 2.5 micrometers (PM_{2.5}) in the area of laser jet printers (LJP) at the Massachusetts Department of Revenue (DOR), Shetland Park Office Complex, 35 Congress Street, Salem, Massachusetts.

On September 17, 2007 a visit to conduct testing was made to this building by Cory Holmes, an Environmental Analyst in BEH's Indoor Air Quality (IAQ) Program. Mr. Holmes was accompanied by Theresa Coscia, Facility Manager DOR Salem and was assisted by Laura Adams, Union Steward as well as other DOR staff during the assessment.

The testing was conducted in follow up to an employee meeting during which DOR staff raised concerns regarding the generation of airborne particulate matter from operating printers and the potential impact on indoor air quality in the building. A previous study of particulate emissions conducted by the International Laboratory for Air Quality and Health, Queensland University of Technology and the Queensland Department of Public Works, in Brisbane Australia showed that office printers contributed to airborne particle concentrations in the work environment (Congrong, et al, 2007). In order to ascertain whether LJPs were emitting particulates above concentrations that may produce irritant symptoms, BEH staff conducted measurements for PM_{2.5} in a manner similar to the Australian study.

Methods

Air tests for airborne particle matter with a diameter less than 2.5 micrometers (PM2.5) were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Tests were conducted in close proximity to LJPs within the DOR space during normal working hours with the heating, ventilation and air-conditioning (HVAC) system operating. PM2.5 measurements were taken directly over each LJP during printing of a 1 to 2 page document as well as during the printing of a larger 10 to 20 page document. PM2.5 measurements were also taken outside and in each work area (approximately 10-feet) away from the LJP for comparison. A total of 11 LJPs were examined: 6 in the east wing, 2 in the central wing and 3 in the west wing. All but one of the printers was located in a common work area (one was located in an office in the east wing). Test results of each printer as well as make and model number are included in Table 1.

Results and Discussion

Airborne Particulate Matter (PM 2.5)

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as fine airborne particulates. Exposure to particulate matter with a diameter of 2.5 micrometers (μm) or less can provide a source of eye and respiratory irritation. To determine whether measurable levels of fine, airborne particulates were present in the indoor environment, BEH staff conducted air measurements for particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems

(ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997).

The US EPA has established NAAQS' to address human exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter ($\mu\text{g}/\text{m}^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, the US EPA established a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 $\mu\text{g}/\text{m}^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations the day of the assessment were measured at 7 $\mu\text{g}/\text{m}^3$ (Table 1). Comparison PM2.5 levels measured approximately 10-feet *away* from printers in each area ranged from 3 to 5 $\mu\text{g}/\text{m}^3$ (Table 1). PM2.5 levels measured directly over LJPs during the printing of 1 to 2 page documents ranged from 4 to 6 $\mu\text{g}/\text{m}^3$ (Table 1). PM2.5 levels measured directly over LJPs during the printing of 10 to 20 page documents ranged from 4 to 7 $\mu\text{g}/\text{m}^3$ (Table 1). While the concentration of PM2.5 directly over the printers was slightly higher

(1-2 $\mu\text{g}/\text{m}^3$), it is important to stress that all PM_{2.5} measurements were below the NAAQS of 35 $\mu\text{g}/\text{m}^3$ and were less than or equal to outdoor concentrations.

Frequently, indoor air levels of particulates (including PM_{2.5}) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Other sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Conclusions/Recommendations

Test results indicated a slight increase in measurable PM_{2.5} levels during the operation of LJPs. However, airborne particulates (PM_{2.5}) measured during the assessment were well below the NAAQS of 35 $\mu\text{g}/\text{m}^3$ and equal to or below background levels of particulate matter measured in the outdoor air.

References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL.

Congrong, et al, 2007. Particle Emission Characteristics of Office Printers. He, C., Morawska, L., and Taplin, L. *Environ. Sci. Technol.*, 41, 17, 6039 - 6045, 2007, 10.1021/es063049z

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

US EPA. 2006. National Ambient Air Quality Standards (NAAQS). US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC.
<http://www.epa.gov/air/criteria.html>.

Table 1
PM2.5 Testing of Laser Jet Printers
DOR, 35 Congress Street, Salem, MA
September 17, 2007

Printer ID/Location	Printer Type/Model #	EPA NAAQS* PM2.5 µg/m^{3**}	Background (outside) PM2.5 µg/m^{3**}	Background (inside ~ 10-feet) away from printer PM2.5 µg/m^{3**}	1-2 pages PM2.5 µg/m^{3**}	10-20 pages PM2.5 µg/m^{3**}
P564 East Wing	hp Laser Jet 4250 dtn	35	7	3	4	4
P749 East Wing	hp Laser Jet 4250 dtn	35	7	3	4	6
P563 East Wing	hp Laser Jet 4250 dtn	35	7	4	5	6
P562 East Wing	hp Laser Jet 4250 dtn	35	7	4	5	7
P561 East Wing	hp Laser Jet 4250 dtn	35	7	4	5	5
P532 Central Wing	hp Laser Jet 4250 dtn	35	7	4	6	7
P480 Central Wing	hp Laser Jet 4250 dtn	35	7	4	5	6
P737 West Wing	hp Laser Jet 4250 dtn	35	7	5	6	7
P572 West Wing	hp Laser Jet 4250 dtn	35	7	4	5	7
P567 West Wing	hp Laser Jet 4250 dtn	35	7	4	5	5
Fraser-Gargas Office	Hp 970 Cxi deskjet	35	7	4	5	6

* EPA NAAQS = US Environmental Protection Agency National Ambient Air Quality Standard (35 µg/m³)

**µg/m³ = micrometers per meter cubed